Report No. R93-08

3420
September 13, 1993

AN EVALUATION OF A MODOC BUDWORM OUTBREAK ON THE MODOC NATIONAL FOREST

Dennis R. Hart, Entomologist

INTRODUCTION

On July 1, 1992 Dennis Hart, Entomologist from the Forest Pest Management Group, Bill Merrihew, Silviculturist on the Modoc National Forest, and Gary Fiddler, Silvicultrist with the Silvicultural Development Unit, monitored the levels of Modoc budworm, *Choristoneura viridis* Freeman, and Sugar pine tortrix, *Choristoneura lambertiana* (Busck), activity on the Warner and Manzanita Mountain areas of the Modoc National Forest.

Heavy to severe levels of larval feeding was observed throughout the true fir and lodgepole pine stands in the north Warner Mountains. On Manzanita Mountain the Modoc budworm larvae caused moderate to heavy feeding damage only at the higher elevations.

Weather patterns like those of the spring of 1993 are very adverse on the development of budworm populations. Warm weather at the time of bud break, followed by a period of cold weather, weaken the newly hatched larvae and predispose them to diseases that can cause the collapse of the budworm populations.

This area will continue to be closely monitored. During the week of July 13 Dave Evans, Silvicultrist on the Warner Mountain District, made an aerial survey of the area of infestation. On the week of July 27th Dennis Hart made an egg-mass survey of the infested area.

The purpose of this evaluation is to locate areas of outbreak, determine the relative population levels for 1992 through 1993.

TECHNICAL INFORMATION

Causal Agents -- Modoc budworm, *Choristoneura viridis* Freeman
Sugar pine tortrix, *Choristoneura lambertiana* (Busck)

Host Trees Attacked -- White fir, *Abies concolor* (Gord. and Glend.) Lindl.
Lodgepole pine, *Pinus contorta* Douglas

Location of Outbreaks -- Five areas of outbreak were observed:

1. Mill Creek - Extending south from Mount Vida to Fandango Pass (T. 47 N., R. 15 E., Sec. 21, 22, 26, 27, 28, 29, 33, 34, 35 and T. 46 N., R. 15 E., Sec. 2, 3, 4, 10, 11, 14, 15, 23, 24, 25, 26, and 36).

2. Hall's Meadow - Extending south from the northern end of Bucks Mountain to the southern end of Cedar Mountain (T. 45 N., R. 15 E., Sec. 32 - 35; T. 44 N., R. 15 E., Sec. 2 - 5, 8, 9, 16, 17, 20, 27, 28, 29, 32, 33, 34; T. 43 N., R. 15 E., Sec. 3, 4, 5, 9, 10, 14, 15, 16, 21, 22, 23, 27; T. 44 N., R. 14 E., Sec. 36; and T. 43 N., R. 14 E., Sec. 1, 2, 11, 12, 13, 14, 23 - 26, and 36).

3. Dry Creek - Extending south from the northern end of Payne Peak to Willow Springs Canyon (T. 42 N., R. 15 E., Sec. 4, 5, 6, 7, 8, 16, and 21; T. 43 N., R. 14 E., Sec. 25 - 27, 34 - 36; T. 42 N., R. 14 E., 1 - 3, 10 - 13, and 14).

4. South Parker Creek - Extending south to Soup Springs (T. 41 N., R. 14 E., Sec. 1, 12, 13, 24, 25, 36; T. 40 N., R. 14 E., Sec. 1, 12 - 14; T. 41 N., R. 15 E., Sec. 2 - 35; T. 40 N., R 15 E., Sec. 1 - 25; T. 41 N., R. 16 E., Sec. 18 - 19; T. 40 N., R. 16 E., Sec. 16 - 21, 28 - 34; T. 39 N., R 16 E., Sec. 3 - 4, and 9 - 10).

5. Mahogany Ridge - Extending east to Camp One Spring (T. 39 N., R. 15 E., Sec. 25 - 36; T. 38 N., R 15 E., Sec. 13 - 24; T. 38 N., R 6 E., Sec. 7 - 11, 14 - 18, and 19 - 23).

SITE AND STAND CONDITIONS

In the north Warner Mountains, during the summer of 1992, heavy defoliation was observed through the true fir and lodgepole pine type. Larval feeding was equally heavy on all levels of the crown canopy. During budworm outbreaks in the past defoliation damage tended to be greatest in only the lower levels of the stands crown canopy, affecting primarily the smaller trees in the stand. This budworm damage was equally severe on all trees in the stands, from the smallest to the largest. All or nearly all the current foliage was stripped from these trees during 1992.

The impact of budworm feeding in the Warner Mountains is usually modified by site, the higher the site classification the less the impact. The current budworm damage appears to be equal across all site classifications.

Another factor that has helped to reduce the effects of the impact of budworm damage in the past has been the fact that the budworm larvae feed on the current buds and the current years needles, leaving the past years needles. With the current drought conditions, the relative amount of past years needles in the crowns of these trees is reduced, impacting the affected trees more severely.

Thinning stands to reduce overstocking stress and increase the relative stand vigor shows promise for reducing the impact of defoliation. Thinned white fir stands were monitored during the last budworm outbreak in the 1980's. In each case budworm populations were equally heavy in both thinned and unthinned stands. Unthinned stands adjacent to thinned stands all had symptoms of crown decline and top kill. None of the thinned stands exhibited symtoms of crown decline or had any trees with top kill. The theory is that trees in thinned stands tend to develop a greater amount of foliage. This allowes them to absorb a greated amount of feeding before they are affected by budworm defoliation.

MANAGEMENT IMPLICATIONS

Outbreaks of western budworms tend to be associated with late successional and climax plant communities in Douglas-fir, white fir, grand fir, and subalpine fir habitat types. Intertree competition intensifies in these types of stands, and moisture stress is accentuated because these trees are less tolerant to drought than their serial counterparts.

During this century our management practices have increased the amount of the budworm's "favorite food" - the shade-tolerant conifer species. These practices have also provided many layers of shade-tolerant understory species which offer dispersing budworm larvae good sites to land and feed, plus many of these stands are under severe stress from overstocking. These conditions have reduced the probabilities of budworm larvae being dispersed to the hostile environment on the forest floor reducing their chances of survival.

Silvicultural practices can be used to reverse these successional trends. To be effective against the budworm, silvicultural practices must render the forest less favorable to the budworm and enable it to withstand and recover from budworm impact. Actions that make the forest less habitable for defoliaters include reducing the amount and type of food, decreasing the flight, feeding and egg-laying opportunities for the budworm, and increasing the opportunities for parasites and predators, and also altering the temperature and moisture conditions to favor tree growth and health. Actions that help the forest withstand budworm attack include increasing stand vigor by converting mature shade-tolerant forests to younger age classes that contain increased proportions of seral species. These stands can then be cultured to reduce the overall stresses of inadequate water, light, nutrients, and stocking levels.

MODOC BUDWORM

LIFE HISTORY AND HABITS

The Modoc budworm is natural to the northeastern California and Oregon area, where it occurs at high levels about once every eight to ten years. These outbreaks continue for about three to five years, when the populations collapse due to natural conditions. The conditions most commonly associated with budworm population decline are weather pattern in the early spring, or over crowding, that predispose the budworm populations to disease.

The Modoc budworm is a small insect that feeds on the buds and current years foliage of fir trees. Unless a large percentage of foliage is destroyed over several consecutive years, budworm feeding does not cause serious damage to the trees. Prolonged heavy defoliation for periods of 3 to 5 years can cause some growth loss, top dieback of the tree crown, the death of smaller understory trees, and cone and seed losses. Under normal conditions these losses do not tend to be serious if the outbreak does not last longer than five years.

The Modoc budworm is similar to other budworms through the United States. Adult females lay their eggs in late July or early August. These eggs hatch in about 10 days. The larvae do not feed at this time, but spin silken shelters in protected places, such as among lichen or under bark scales, in which they hibernate. During the next spring they emerge from their shelters and mine old needles until the buds swell. Then they bore into the buds and feed on the expanding new needles. Later they loosely web the growing tips and feed on the new needles.

When attacks are heavy, entire trees are stripped of new foliage and large forest areas take on a brownish, scorched appearance. Even moderate feeding tends to reduce growth, weaken the trees, and render them susceptible to later damage by secondary insect enemies such as sawflies and needleminers.

Outbreaks of secondary insects such as the the white fir sawfly, in conjunction with the budworm can have very severe effects, because the budworms feed on the new foliage and the sawflies feed on the older years foliage. This can cause very serious levels of defoliation.

Modoc budworm populations are normally held in check by combinations of several natural conditions: parasites, predators, diseases, adverse climatic conditions, and site and stand conditions.

Warm weather followed by extremely cold conditions when the larvae first begin to feed in the early spring before the new years foliage develop have been effective in causing budworm populations to collapse. This is the weather pattern in the Warner Mountains during the spring of 1993.

THE SUGAR PINE TORTRIX

LIFE HISTORY AND HABITS

The life history of the Sugar pine tortrix is simular to the Modoc budworm. The first instar larvae overwinter in silken hibernacula in crevices in the bole and branches of trees. In the spring, when new shoot development is nearly complete, the larvae mine the need sheaths and staminate cones. Numbering one to five per shoot, the larvae web the needles into feeding shelters. Pupae are formed among the webbed needles. Adults fly in July and August. The preferred host is lodgepole pine. At times this insect is destructive to sugar pine.

SILVICULTURAL STRATEGIES TO REDUCE SUSCEPTIBITITY

SPECIES COMPOSITION

Stand susceptibility increases as the proportion of host increases. Host conifers for budworm are white fir, grand fir, Douglas-fir, Englemann spruce, and western larch. The amount of climax host is a key factor influencing susceptibility, but stands supporting a diversity of seral, shade-intolerant species are less susceptible.

STAND DENSITY

Overstocked, dense host forests are high-quality habitat for these insects. Dispersing larvae are more likely to reach food and shelter than they would in a relatively more open stand. Stressed trees, characteristic of overstocking, may be nutritionally better for feeding larvae, and adults are more likely to find good sites for laying their eggs in dense stands.

STAND HEIGHT-CLASS STRUCTURE

Multistoried stands are good habitat for budworms. Larvae disperse and move around a lot during feeding, and much of their dispersal is downward. Intermediate crown strata catch many of the dispersing larvae and tend to perpetrate the feeding activity. In stands with only one crown stratum, dispersing larvae tend to fall to the ground, where they tend to be consumed by ants, birds, and other predators.

TREE AND STAND VIGOR

Fast growing, vigorous trees and stands are not as good habitat for budworm development as are unhealthy, stagnated stands. Also, fast growing vigorous trees tend to out grow the effects of heavy budworm feeding.

ADJACENT HOST TYPE

Location and nature of the adjacent forest can be very important to the susceptibility of stands. Host stands surrounded by or adjacent to nearly

continuous host forest are inherently more susceptible than stands adjacent to nonhost or mixed forests.

NUTRIENT AVAILABILITY

Silvicultural measures to reduce the risk of budworm damage should focus on the protection and improvement of soil organic matter, nutrient cycling, and nutrient availability.

A GENERALIZED MODEL TO RATE THE SUSCEPTIBILITY OF STANDS TO BUDWORM DAMAGE

N. William Wulf and Clinton Carlson have developed a model to calculate an index of the relative susceptibility of stands to budworm impact. This model is based on the interpretation of budworm literature throughout the West and reflects what is known about the interaction of this insect and its habitat.

REGIONAL CLIMATE - General climate significantly affects budworm population dynamics. Climate tends to be cool and moist where outbreak frequency is low, but warm and dry where outbreak frequency is high.

SITE CLIMATE - Given that the regional climate is favorable to the budworm, stands on warm, dry sites are the most susceptible. Warm, dry conditions accelerate larval development and tend to stress host trees.

SPECIES COMPOSITION - Stands composed primarily of host species are more susceptible than mixed stands because more food is available to developing larvae and more sites are present for egg deposition. Stands that are composed primarily of host species that are shade tolerant tend to be more susceptible than are stands that have a sizable component of shade-intolerant host species.

STAND DENSITY - Dense host stands are more susceptible than are more open stands because of increased foliar biomass and increased water and nutrient stress.

STAND HEIGHT-CLASS STRUCTURE - Multistoried stands are more susceptible than are single storied stands. The lower stories significantly reduce the mortality of the dispersing larvae and provide additional substrate.

TREE AND STAND VIGOR - Stressed stands with low vigor tend to be more susceptible. The quality of the foliage as food is enhanced. Low-vigor stands tend to have an altered terpene regime that weakens tree resistance.

MATURITY OF TREES AND STANDS - Older, mature host stands tend to be more susceptible than are young stands. Older stands have far greater biomass than young stands that can support much larger

populations of this insect. Young even-aged stands host stands less than 30 years old are poor habitat for budworm populations; besides having lower biomass, they offer little protection to developing larvae. Small larvae are easily sought out and killed by birds, ants, and other preditors and are easily dislodged from feeding sites during stormy weather. Conversely, uneven-aged host growing under the canopy of larger host trees tend to be heavily damaged by budworm larvae.

ADJACENT HOST TYPE - Stands in close proximity to forests composed of host species tend to be more susceptible than are relatively isolated stands. The probability of adult invasion is much higher when large quantities of a suitable host are nearby. These adjacent forests can produce large budworm populations that inundate and cause significant damage in otherwise resistant stands. Stands downwind of extensive host forests are more susceptible than those upwind.

EXPOSURE - Stands on southerly aspects, upper slopes, and ridgetops tend to sustain the heavier defoliation.

NUTRIENTS - The operational environment of outbreak-prone habitats in both cool and warm sites appear to reflect an ecosystem in which the mineral nutrient cycle is "discoupled" of the nutrient uptake during periods of high demand is inadequate to permit the synthesis of plant defenses against budworm feeding. An environment characterized by lack of organic matter decomposition, tieup of mineral nutrients in plant biomass and impaired nutrient cycling increase the risk of potential budworm susceptibility. Poorly developed soils and increased soil acidity magnify this problem. Poorly developed soils and low mineralization rates, combined with the destruction of woody residues and duff by fires lead to the impairment of the nutrient cycle. The inadequate uptake of nutrients, magnified by moisture stress, impairs the synthesis of plant defenses to budworm activity. Based on the premise that stress from nutrient deficiency increases hazard, silvicultural measures aimed at reducing risk to budworm damage should focus on protection and improvement of soil organic matter, nutrient cycling, and nutrient availability.

WEATHER - The most dramatic factor affecting budworm populations is weather. Periods of warm, dry weather have preceeded most major outbreaks. Unseasonable fall or spring frosts can act directly through freezing of the larvae, and indirectly through destruction of the food supply. This weakens the surviving budworm popluations, and makes them more susceptible to disease. If disease is not effectively introduced into the bubworm populations, they tend to revive following the freeze even when they are reduced by as much as 90 percent. Long periods of warm weather in the fall deplete nutrient reseves in hibernating larvae; after emergence, they tend to be too week to effectively locate and penetrate needles or buds and starve. Four climatological variables were used in developing a

method of discriminant function analysis to predict budworm outbreak potential by geographical region. These variables are: January mean minimum and maximum temperatures (JAMN) and (JAMX), and July mean minimum and maximum temperatures (JLMN) and (JLMX). These variables are used to predict the likelihood of high, medium, or low outbreak-frequencies for a given location. The classification function coefficients used to predict the outbreak-frequency class are:

High = -273.8 + 2.9(JLMX) + 4.6(JLMN) + 4.4(JAMX) - 3.8(JAMN)

Medium = -278.0 + 3.0(JLMX) + 4.5(JLMN) + 4.2(JAMX) - 3.3(JAMN)

Low = -264.8 + 3.0(JLMX) + 4.2(JLMN) + 4.1(JAMX) - 2.9(JAMN)

For a given location, a score is calculated for each of the above functions. The location is assigned to the class having the highest value.

Managers can use these basic rules for determining relative stand susceptibility to budworm damage to map geographic areas according to potential hazard and can be used to select areas for silvicultral treatment to reduce stand susceptibility.

The weather station at Jess Valley as used for this example. The scores for 1993 are:

High = 266.2

Medium = 266.4

Low = 268.8

The low outbreak-frequency function has the highest score. This means that at Jesse Valley 0 - 11 percent chance that an outbreak can be expected in during 1994. So far we do not have weather records where the budworm outbreaks commonly occur. Jesse Valley is included in the overall area of budworm activity, but is about 200 feet lever in elevation than the lower limit of the white fir type.

EGG MASS SURVEY

Egg mass sampling was done through the Warner Mountains and Mahogany Ridge, and Manzanita Mountain. Road junctions within these areas were selected at random as sample plot locations. Each sample plot consisted of a length of 18 inches clipped from the tips of three branches from the mid-crowns of three trees approximately 40 feet tall.

Defoliation predictions for 1993 were determined from the density of egg masses per thousand square inches of foliage.

Figure 1. Prediction Of Defoliation From Egg Mass Densities.

Egg masses Per M sq. in.	Defoliation Category	Defoliation Percent
0.0 - 1.3	Very light	0 - 15
1.4 - 3.5	Light	16 - 25
3.6 - 8.9	Moderate	26 - 50
9.0 - 17.7	Heavy	51 - 90
17.8+	Very heavy	91 - 100

Figure 2. 1991, 1992 Egg Mass Densities And 1993 Defoliation Classifications For Budworm Plots On The Modoc National Forest

Area	Plot Location Twp,Rge,Sec.,1/4 Sec.	Egg Masses Per M Sq. In. 1992	Predicted Level Of Defoliation For 1993
Lilly Lake	48N., 15E., 35SW	1.1	Very Light
	47N., 15E., 02NE	0.0	Very Light
Mill Creek	47N., 15E., 21SE	12.8	Heavy
	47N., 15E., 34NW	5.7	Moderate
	47N., 15E., 05SW	4.5	Moderate
Davis Creek	45N., 14E., 22SE	1.7	Light
	45N., 15E., 29NE	2.3	Light
Buck Mountain	45N., 15E., 23SE	6.4	Moderate
Benton Meadow	44N., 15E., 17NW	5.7	Moderate
Halls Meadow	44N., 15E., 08NW	7.1	Moderate
	44N., 14E., 13NE	6.2	Moderate
Stough Res.	43N., 15E., 26SE	2.9	Light
	43N., 15E., 27NE	2.3	Light
South Deep Cr.	42N., 15E., 06SE	3.5	Light
Parker Creek	41N., 15E., 06NW	3.7	Moderate
Fitzhugh Creek	41N., 14E., 25SW	1.9	Light
	40N., 15E., 05NE	0.6	Very Light
	40N., 15E., 04SW	0.0	Very Light
Soup Springs	40N., 15E., 17SE	0.0	Very Light
Corporation Mdw	39N., 15E., 36NE	0.5	Very Light
Parsnip Spr.	38N., 15E., 15SE	1.6	Light
Camp One Spr.	38N., 16E., 15NW	1.4	Light
Buck Mountain	38N., 16E., 20NE	1.3	Very Light
Manzanita Ridge	40N., 10E., 35SW	0.0	Very Light
Hunter's Ridge	40N., 10E., 21SE	0.0	Very Light
	40N., 10E., 27SE	1.2	Very Light

TREATMENT PRIORITIES

Treatment priority classifications were determined using a combination of the factors used to rate stand susceptibility, ie, regional climate, site climate, stand species composition, stand density, height-class structure, vigor adjacent host type, exposure, nutrients, and weather, plus successive years of defoliation, level of current defoliation, number of budworm egg masses per thousand square inches of foliage, population trend (increasing, decreasing, or stable), number of parasites, and number of diseased larvae and pupae.

Figure 3. Treatment Priority Classifications for the Modoc National Forest

Treatment Priority Ratings And Classifications

Ratings	Classifications
0 - 1	Very Low
2 - 7	Low
8 - 11	Intermediate
12+	High

The treatment priority classification for the general areas within the budworm outbreak area on the Modoc National Forest are given in figure 4.

Figure 4. Treatment Priority Classifications for Zones Within the Modoc Budworm Outbreak Area

Treatment Priority Classifications by Area

Area	Rating	Classification
Pine Creek	7	Low
Mill Creek	12	High
Davis Creek	2	Low
Benton Meadow	13	High
Stough Reservoir	9	Intermediate
Deep Creek	14	High
Parker Creek	5	Low
Soup Springs	3	Low
Parsnip Springs	4	Low
Camp One Springs	2	Low
Manzanita Mountain	2	Low

Results and Discussion:

Mill Creek, Buck Mountain, Benton Meadow, Hall's Meadow, and Parker Creek are the areas where budworm impact is predicted to be moderate to high during 1993. Due to the weather conditions during the spring of 1993 these budworm populations were reduced. This impact can be effectively stabilized at a low level by silvicultural treatment.

ALTERING STAND SUSCEPTIBILITY TO BUDWORM IMPACT

Common silvicultural treatments will reduce stand susceptibility to impact by budworm populations. Stand factors that can be changed include: stand composition, density, height-class structure, vigor, maturity, and the nature of the adjacent forest. These silvicultural treatments can enhance habitat for birds that prey on the budworm as well as reduce their susceptibility to this insect.

The objective in altering stand conditions are to reduce the proportion of host, capitolize on resistant genotypes, regulate stand density so that growth is optimized and vigor is improved, and enhance conditions for budworm predators and parasites. Attaining these objectives will reduce budworm populations to acceptable levels and lower the stand susceptibility indicies in managed stands.

The general methods for altering stand susceptibility to budworm damage are: (1) even-aged methods; (2) uneven-aged methods; and (3) intermediate cuts in existing stands.

Even-Aged Methods:

Even-aged silvicultural methods are particularly effective in minimizing budworm habitat. The objective of clearcut, seed-tree, and shelterwood regeneration harvest cuts is to establish even-aged vigorous seral conifer stands. These even-aged methods dramatically reduce susceptibility of the treated stands at the time they are done. All understory conifers are removed either at the time of harvest or just before site preparation, and various amounts of the overstory are removed, depending on the type of cut.

Even-aged methods mimic natural ecological processes that operated before the late 1880's, when fire played a dominant role in regulating forest and stand conditions. Stand-replacing fires in effect "clearcut" much of the area burned and prepared the site for conifer regeneration by eliminating competing vegetation and exposing mineral soil. Less intense fires resembled today's seed-tree and shelterwood cuts in that they removed fire-susceptible conifer species that are host for the budworm, created holes in the overstory canopy, prepared the site for regeneration, and favored fire-resistant seral conifers such as ponderosa pine.

Planting gives the silviculturist control over species composition to assure that the future stand will be budworm resistant. The new stand should not be more than 30 percent climax host species.

Once desired stocking is attained in the seed-tree or shelterwood methods, the overstory should be removed. Even if the overstory is nonhost to the budworm, many larvae can overwinter in bark fissures of the residual trees and disperse to the young stand. Removal of the residual overstory within ten years of the harvest cut will help protect the new stand.

The density of the regenerated stand should be regulated to optimize growth and development. Thinning will increase stand vigor, increase budworm larval mortality by increasing dispersal losses, and further reduce the amount of host habitat. A first-entry, precommercial thinning between 20 and 30 years of regeneration is desirable. A commercial thinning when the stand is between 50 and 60 years old is also recommended.

Uneven-Aged Methods:

Uneven-aged silvicultural methods can be used against the budworm, but only in certain habitats. Uneven-aged methods are probably not effective against budworm on warm, moist habitats because shade-tolerant species that are principal budworm host and would be difficult to regulate.

In very cool, moist habitats at high-elevations uneven-aged management methods may be practical.

In cool, dry habitats, seral conifer species are lacking. In these stands, species conversion is usually not a viable alternative; therefore, susceptibility to budworm impact must be reduced by regulating stand density, stand vertical structure, growth, and maturity.

Intermediate Cuts in Existing Stands:

Throughout the range of western budworm populations, many host stands are not ready for regeneration harvest cuts. These stands exist today because the old-growth seral stands were harvested during the early 1900's with little thought of the character of the succeeding stands. Fire was controlled, and shade-tolerant species that are favored budworm hosts took over. These stands now provide a tremendous amount of habitat for this insect. Most of these stands are overstocked, of low vigor, and multistoried. These conditions favor budworm development.

Intermediate-aged host stands can be thinned to improve stand vigor, reduce the amount of host biomass, and increase the rate of mortality of dispersing larvae.

Only the most vigorous dominant and codominant trees should be left on the site. All understory should be slashed. Depending on the size of products and existing markets, some revenues may be generated by these intermediate cuts. More often, the treatments will have to be considered an investment to reduce future losses and increase the health and vigor of these stands.

PROTECTED AREAS

A large amount of good budworm habitat is protected by Federal law from harvesting. These stands exist in designated wilderness, National Parks, and other special areas. They developed after fire was virtually eliminated from these areas. Budworm-susceptible stands in protected areas will continue to be a refuge for budworm populations. Currently, forest managers are developing plans to restore fire to its natural role in these areas. If they are successful, a large amount of budworm habitat will be eliminated. The hazard posed by budworm-susceptible forests in protected areas should be addressed when these plans are being developed.

STRATEGY FOR REDUCING FOREST SUSCEPTIBILITY TO BUDWORM IMPACT

Budworm-susceptible forests cover a significant proportion of the Warner Mountain District of the Modoc National Forest. Many conifer stands of varing character in the drainages in this area. These stands should be rated and classified for relative susceptibility to this insect. The most susceptible stands should be silviculturally treated first, followed by those of less risk. Eventually, these drainages will support a mosaic of budworm resistant stands. Meanwhile, overall forest susceptibility will be reduced by altering the most susceptible stands first. As more drainages are treated, the forests will become less and less susceptible.

BUDWORM POPULATION MONITORING

On August 24th an aerial survey designed to map budworm activity in the Warner Mountains was made. During the week of September 20th Dennis Hart will conduct an budworm population survey to predict the outbreak potential for 1994.

SELECTED REFERENCE

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Reply To: 3420

Date: SEP 14 1993

Subject: Bio-Evaluation of Modoc Budworm Outbreak on the Modoc National Forest, Report No. R93-08

To: Forest Supervisor, Modoc NF

The enclosed report documents an ongoing evaluation of the Modoc budworm impact on the Warner Mountains Ranger District of the Modoc National Forest. Management alternatives are developed.

If you have any questions about the report, please contact Dennis Hart of State and Private Forestry at (415) 705-2574

John Neisess

JOHN NEISESS, FPM Program Leader
State and Private Forestry

Enclosure